Aerial Data

AS-75

KODAK DOUBLE-X AEROGRAPHIC Film 2405

KODAK DOUBLE-X AEROGRAPHIC Film 2405 is a panchromatic, negative aerial camera film with good contrast for easier interpretation from negatives, high resolution, and wide exposure latitude. Its extended red sensitivity permits greater speed with the filters used for the reduction of atmospheric-haze effects.

The ESTAR Base provides flexibility, moisture resistance, high tear resistance, and excellent dimensional stability. This film has a thin, highly hardened, and abrasion-resistant emulsion that permit high-temperature rapid processing in modern continuous-processing machines.

This film can be processed in the KODAK VERSAMAT Film Processor, Model 11 or 1140, with KODAK VERSAMAT 885 Chemicals, KODAK VERSAMAT 641 Chemicals, or KODAK VERSAMAT Chemicals, Type A. KODAK DOUBLE-X AEROGRAPHIC Film 2405 can also be processed at normal temperatures in conventional rewind equipment, such as the Gordon/Morse M-10 Developing Outfit (Military Designator: B-5) using a variety of Kodak black-and-white developers

APPLICATIONS

KODAK DOUBLE-X AEROGRAPHIC Film 2405 is a medium- to high-speed film for aerial mapping, charting, and general aerial photography.

BASE

3.9-mil (0.10 mm) ESTAR Base with a dyed-gel backing

TOTAL FILM THICKNESS

The nominal total thickness (unprocessed) of this film is **4.50 mils** (0.114 mm). This includes emulsion—0.40 mil (0.010 mm), base—3.9 mils (0.10 mm), and backing—0.20 mil (0.005 mm).

WEIGHT

The weight of 2405 Film (unprocessed), conditioned in equilibrium with 50 percent relative humidity, is **0.035 lbs⁄ft²** (0.0159 kg/ft²).

SPECTRAL SENSITIVITY

Panchromatic, with extended red sensitivity.

SAFELIGHT

Total darkness is required.

EXPOSURE

Aerial film speeds (ISO A or EAFS) should not be confused with conventional film speeds which are designed for roll and sheet films used in pictorial photography. The characteristics of aerial scenes differ markedly from those of ordinary pictorial or ground scenes because of the smaller range in subject luminances, atmospheric haze conditions, and other factors. Therefore, different film-speed parameters are used to relate aerial-scene characteristics to practical exposure recommendations. The KODAK Aerial Exposure Computer, KODAK Publication AS-10 has been published based on the aerial film speed criterion.

Nominal speed, daylight (no filter): EAFS or ISO A **400**

Other suggested aerial film speeds for processing this film in the KODAK VERSAMAT Film Processor, Models 11 or 1140, using VERSAMAT 885 Chemicals, 641 Chemicals and Type A Chemicals can be found in the sensitometric data tables.

Note: The aerial film speeds given in this publication were obtained by rounding the calculated values to the nearest cube root of 2 step (equivalent to 1⁄3 stop).

Filters

KODAK PROFESSIONAL WRATTEN Gelatin Filter					
	No. 3	**No. 8**	**No. 12**	**No. 15**	**No. 25**
Filter Factor	1.5	2	2	2.5	4

Typical Camera Exposure

A typical exposure for this film is approximately 1⁄750 second at f⁄8. This exposure is based on a solar altitude of 40 degrees, a clear day, an aircraft altitude of 5,000 feet, and a speed of ISO A 400, using a 2X antivignetting filter.

Reciprocity Characteristics

No exposure or development time adjustments are required for exposure times from 1⁄1,000 second to 1⁄10 second; at 1⁄10,000 second, increase the development time by 10 percent.

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IMAGE STRUCTURE

The following data are based on processing in KODAK VERSAMAT Film Processors, Model 11, using KODAK VERSAMAT Chemicals at the conditions noted.

Developer	Resolving Power (line pairs/mm)		rms Granularity*
	TOC 1.6:1	TOC 1000:1	
885	50	125	26
641	40	125	26
Type A	38	94	42

*Granularity values read at a net diffuse density of 1.0 with a 48-micrometre aperture.

Process conditions to achieve above values:

885 Chemicals:15 fpm, 85°F (29.5°C), process gamma 1.10
641 Chemicals: 5 fpm, 85°F (29.5°C), process gamma 1.30
Type A Chemicals: 10 fpm, 90°F (32°C), process gamma 1.65

STORAGE

For consistent results, all aerial films should be stored under fairly constant conditions. Kodak aerial films are "usually" packaged in equilibrium with 40 to 50 percent relative humidity. High temperatures or high humidity may produce undesirable changes in the film.

Unexposed Film

Store unexposed film in a refrigerator at 55°F (13°C) or lower, or freezer at 0 to -10°F (-18 to -23°C), in the original sealed container. If the film is stored in a refrigerator, remove it about 2 hours before opening; if stored in a freezer, remove it about 8 hours before opening. A sufficient warm-up time is necessary to prevent moisture condensation on cold film -- otherwise, moisture spotting, ferrotyping, or sticking may occur.

Exposed Film

Keep exposed film cool and dry. Process the film as soon as possible after exposure to avoid undesirable changes in the latent image. If it is necessary to hold exposed but unprocessed film for several days (such as over a weekend), it should be resealed and refrigerated at 40°F (4°C) or lower. Before unsealing and processing exposed film that has been held in cold storage, follow the warm-up procedures described for unexposed film described above.

Processed Film

For best keeping, store processed film in a dark, dust-free area at 50 to 70°F (10 to 21°C) and 30 to 50 percent relative humidity. Preferably, store negatives on the spool or in individual KODAK PROFESSIONAL Sleeves. High relative humidity promotes the growth of mold and causes ferrotyping. Very low relative humidity causes excessive curl and brittleness. Avoid storage temperatures over 80°F (27°C).

PROCESSING

KODAK DOUBLE-X AEROGRAPHIC Film 2305 can be processed in KODAK VERSAMAT Film Processor, Models 11 and 1140, with KODAK VERSAMAT 885 Chemicals, KODAK VERSAMAT 641 Chemicals, or KODAK VERSAMAT Chemicals, Type A.

Mechanized processing in roller-transport processors offers the advantages of uniform treatment of all portions of the roll, freedom from banding, and absence of significant density variations from ends of the roll to the center. Refer to the operator's manual for the processor set-up information, but in all cases, the fixer replenisher should be introduced into tank No. 5 of the processor with a countercurrent flow to tank No. 3, where it overflows to a collection or recovery system.

General instructions for setting the machine dryer temperature are included in these pages. However, the temperature of the dryer may require some further adjustment, depending upon the ambient temperature conditions in the processing area. Usually it is best to set the temperature approximately 3°F (2°C) above that required to dry unexposed, processed film.

Chemicals

The following KODAK VERSAMAT Chemicals may be used in both the Model 11 and Model 1140 VERSAMAT Processors.

KODAK VERSAMAT 885 Developer Starter

KODAK VERSAMAT 885 Developer Replenisher

KODAK VERSAMAT 885 Fixer and Replenisher

KODAK VERSAMAT 641 Developer Starter

KODAK VERSAMAT 641 Developer Replenisher

KODAK VERSAMAT 641 Fixer and Replenisher

KODAK VERSAMAT Developer Starter, Type A

KODAK VERSAMAT Developer Replenisher, Type A

KODAK VERSAMAT Fixer and Replenisher, Type A

Notice: Observe precautionary information on product labels and on the Material Safety Data Sheets.

Replenishment Rates

Basic developer and fixer replenishment rates, in millilitres per square inch of film processed, vary depending upon the type of chemicals used. The following rates apply to processing in the VERSAMAT Processor, Models 11 and 1140.

Basic Replenishment Rates (mL/in²) KODAK VERSAMAT Chemicals			
	885	**641**	**Type A**
Developer	0.29	0.31	0.20
Fixer	0.45	0.68	0.34

Processing Sequence (All Recommended Chemicals)

KODAK VERSAMAT Processor, Model 11			
Processing Step	**No. of Racks**	**Path Length**	**Temperature**
Develop*	1 or 2	1.2 or 2.4 m (4 or 8 ft)	85 ± 0.5°F (29.5 ± 0.3°C)
Fix	3	3.6 m (12 ft)	85°F (29.5°C), nominal
Wash	2	2.4 m (8 ft)	2 to 6°F (1 to 3°C) below developer temperature
Dry	—	2.4 m (8 ft)	135 to 145°F (57 to 63°C)

*Use 90°F (32°C) for KODAK VERSAMAT Chemicals, Type A.

Sensitometric Data

Model 11—KODAK VERSAMAT 885 Chemicals 85°F (29.5°C)						
Machine Speed (fpm)	**1 Developer Rack**			**2 Developer Racks**		
	Average Gamma	**ISO A**	**D-min**	**Average Gamma**	**ISO A**	**D-min**
5	1.25	500	0.21	—	—	—
10	0.90	250	0.12	1.30	500	0.22
15	0.80	160	0.11	1.10	400	0.16
20	0.70	100	0.10	1.00	250	0.14
25	0.65	64	0.10	0.85	200	0.13

Fixing: Adequate fixing is obtained at machine speeds up to and including 20 feet per minute.

Washing: LE-100 keeping quality is obtained at machine speeds up to and including 10 feet per minute with one developer rack and up to 5 feet per minute with two developer racks. (LE = Life Expectancy)

Drying: Adequate drying is obtained at machine speeds up to and including 20 feet per minute.

Model 11, KODAK VERSAMAT 641 Chemicals 85°F (29.5°C)						
Machine Speed (fpm)	**1 Developer Rack**			**2 Developer Racks**		
	Average Gamma	**ISO A**	**D-min**	**Average Gamma**	**ISO A**	**D-min**
5	1.05	320	0.12	1.70	500	0.21
10	0.85	160	0.10	1.10	320	0.13
15	0.65	80	0.13	0.95	250	0.13
20	0.60	50	0.13	0.85	160	0.15
25	0.50	32	0.12	0.80	125	0.14

Fixing: Adequate fixing is obtained at machine speeds up to and including 10 feet per minute.

Washing: To be determined.

Drying: Adequate drying is obtained at machine speeds up to and including 12 feet per minute.

Model 11, KODAK VERSAMAT Chemicals, Type A, 90°F (32°C)						
Machine Speed (fpm)	**1 Developer Rack**			**2 Developer Racks**		
	Average Gamma	**ISO A**	**D-min**	**Average Gamma**	**ISO A**	**D-min**
5	1.20	400	0.11	2.15	500	0.13
10	1.00	160	0.09	1.65	320	0.11
15	0.85	80	0.09	1.20	250	0.10
20	0.75	64	0.09	1.05	160	0.10

Fixing: Adequate fixing is obtained at machine speeds up to and including 10 feet per minute.

Washing: To be determined.

Drying: Adequate drying is obtained at machine speeds up to and including 10 feet per minute.

Processing Sequence (All Recommended Chemicals)

KODAK VERSAMAT Processor, Model 1140			
Processing Step	**No. of Racks**	**Path Length**	**Temperature**
Develop	1 or 2	1.2 or 2.4 m (4 or 8 ft)	99 or 104 ± 0.5°F (37 or 40 ± 0.3°C)
Fix	3	3.6 m (12 ft)	99 or 104°F (37 or 40°C), Nominal
Wash	2	2.4 m (8 ft)	2 to 6°F (1 to 3°C) below developer temperature
Dry	—	2.4 m (8 ft)	Up to 149°F (65°C)

Sensitometric Data

Model 1140 -- KODAK VERSAMAT 885 Chemicals						
Machine Speed (fpm)	1 Developer Rack			2 Developer Racks		
	Average Gamma	ISO A	D-min	Average Gamma	ISO A	D-min
99°F (37°C)						
10	1.50	500	0.28	—	—	—
20	0.90	320	0.18	1.65	500	0.32
30	0.75	200	0.13	1.10	400	0.25
40	0.65	125	0.12	0.90	320	0.19
104°F (40°C)						
10	1.60	500	0.34	—	—	—
20	0.85	320	0.20	—	—	—
30	0.80	250	0.16	1.40	500	0.34
40	0.75	200	0.15	1.05	400	0.28

Model 1140 -- KODAK VERSAMAT 641 Chemicals						
Machine Speed (fpm)	1 Developer Rack			2 Developer Racks		
	Average Gamma	ISO A	D-min	Average Gamma	ISO A	D-min
99°F (37°C)						
10	1.20	400	0.15	2.20	500	0.37
20	0.80	250	0.11	1.20	400	0.16
30	0.70	125	0.10	1.00	320	0.13
40	0.60	80	0.14	0.85	250	0.16
104°F (40°C)						
10	1.50	500	0.20	—	—	—
20	0.90	320	0.12	1.55	500	0.24
30	0.70	160	0.10	1.10	400	0.16
40	0.60	100	0.14	0.95	320	0.18

Model 1140 -- KODAK VERSAMAT Chemicals, Type A

This is not a primary processing recommendation, although satisfactory results can be obtained at processor speeds up to 10 feet per minute. Refer to the processing conditions and sensitometric data for the KODAK VERSAMAT Processor, Model 11, above.

REWIND OR SPIRAL REEL PROCESSING

KODAK DOUBLE-X AEROGRAPHIC Film 2405 yields optimum results with modern, high-temperature, continuous-processing machines. It can be processed in rewind equipment or on spiral reels, although these methods are not primary processing recommendations. Customers wishing to use spiral reels or rewind equipment such as the Gordon/Morse M-10 Developing Outfit (Military Designator: B-5) may contact Aerial Systems for information on exposure, processing chemicals, process cycles, and general recommendations.

DIMENSIONAL STABILITY

The dimensional stability of aerial films is of particular interest and importance in accurate mapping and in the reproduction of maps.

Dimensional stability is an all-inclusive term. In photography, it applies to size changes caused by changes in humidity and in temperature, and by processing and aging. The absence of solvent in ESTAR Base is one of the reasons why ESTAR Base films show excellent dimensional stability. The dimensional properties of ESTAR Base may vary slightly in different directions within a sheet; the differences that may exist, however, are not always between the length and width directions.

Temporary Dimensional Changes

Thermal Coefficient of Linear Expansion:	
0.001%	per degree F of change
0.0018%	per degree C of change

Humidity Coefficient of Linear Expansion (Unprocessed):	
0.002%	per 1% change in relative humidity

Permanent Dimensional Changes

Processing Dimensional Change:	
-0.03% to +0.01%	shrinkage to swell

Aging Shrinkage of Processed Film:	
0.03%	1 week at 120°F (49°C), 20% RH
0.03%	1 year at 78°F (25.5°C), 60% RH

SIZE DATA AND ORDERING INFORMATION

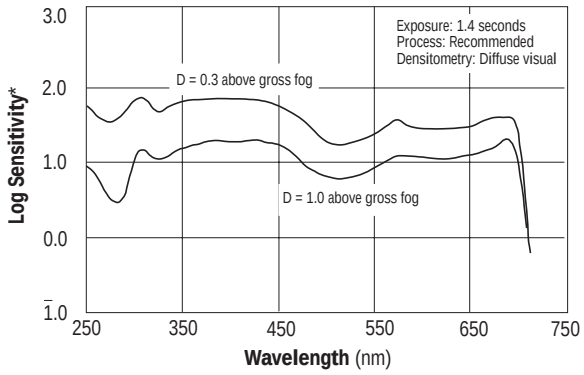
Information on available sizes and minimum order quantities of this film is available on the web at **www.kodak.com/go/aerial**. You can also write or call:

Aerial Imaging
Eastman Kodak Company
343 State Street
Rochester, New York 14650-0505
(585) 724-4688
Toll-free in the US: (877) 909-4280

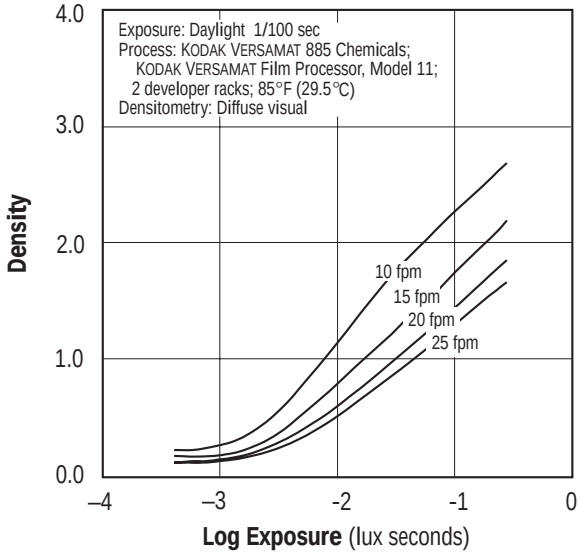
Note: The Kodak materials described in this publication used with KODAK DOUBLE-X AEROGRAPHIC Film 2405 are available from those dealers normally supplying Kodak products. Other materials may be used, but equivalent results may not be obtained.

CURVES

Spectral Sensitivity

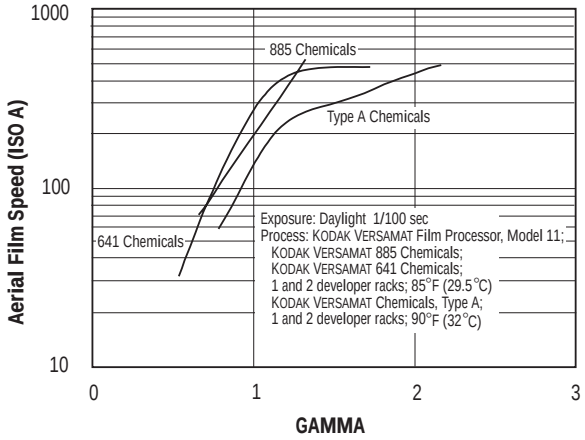


Characteristic Curves

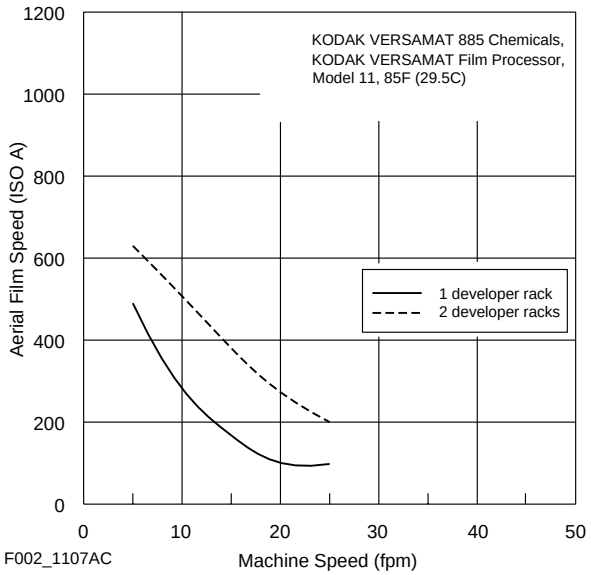


KODAK DOUBLE-X AEROGRAPHIC Film 2405

ISO A vs. Gamma

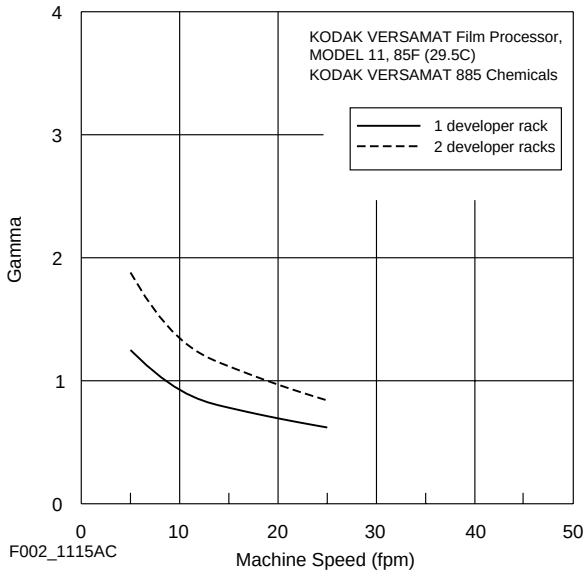


ISO A vs. Machine Speed



F002_1107AC

Gamma vs. Machine Speed



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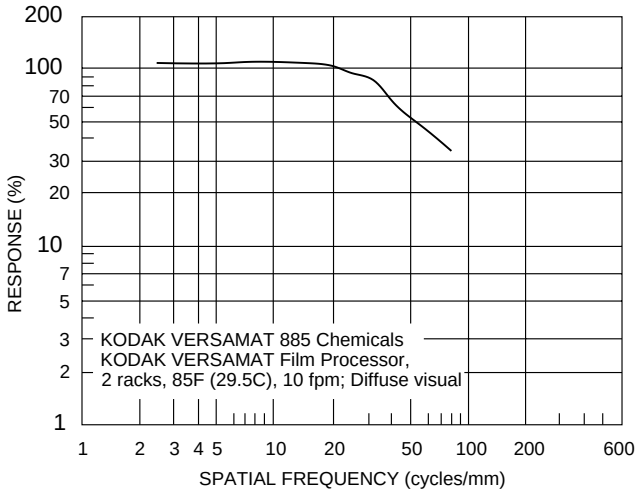
Modulation Transfer Function



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NOTICE: While the sensitometric data in this publication are typical of production coatings, they do not represent standards which must be met by Kodak. Varying storage, exposure, and processing conditions will affect results. The company reserves the right to change and improve product characteristics at any time.

Aerial Imaging
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